

REMARKS

Applicants appreciate the thorough and detailed examination of the present application as evidenced by the Office Action dated April 11, 2007 (hereinafter, the "Office Action"). Claims 1-69 are pending in the present application. Claims 7-10 and 16-69 have been withdrawn from consideration. Claims 1-6 and 11-15 stand rejected. Applicants have amended pending Claims 1, 5, 6, 12 and 13 and withdrawn Claims 7 and 61-63 herein to recite methods of forming dielectric films. Support for these amendments may be found, *e.g.*, on page 8, line 31 through page 9, line 4, of the specification. In addition, pending Claim 4 and withdrawn Claim 49 are amended herein to correct an inadvertent typographical error in the formula for lanthanum (III) ethoxide; the corrected formula now recites $\text{La}(\text{OC}_2\text{H}_5)_3$. Support for this amendment may be found, *e.g.*, on page 12, lines 14-15, of the specification. Applicants provide the comments below to address the issues presented in the Office Action and in support of the patentability of the pending claims.

Interview Summary

Applicants extend their gratitude to Examiner Ori Nadav for the telephonic interview conducted on June 13, 2007 with Applicants' representatives Lori W. Herman and Shawna Cannon Lemon.

The participants discussed the prior election of the species of Figure 1B. Applicants' representatives and Examiner Nadav agreed that pending claims Claims 1-6 and 11-15 read on species of Figure 1C and Figure 1D. However, Examiner Nadav indicated that Applicants should continue to argue the merits of pending Claims 1-6 and 11-15 in the present application. It is Applicants' understanding that upon allowance of generic Claim 1, Applicants will be allowed to rejoin withdrawn claims 7-10 and 16-69. In the event that generic Claim 1 is not allowed, Applicants can address the issue of the election of species upon filing a Request for Continued Examination.

Claims 1-6 and 11-15 Are Not Indefinite

The Office Action states that Claims 1-6 and 11-15 are rejected under 35 U.S.C. §112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. *Office Action*,

page 2. Specifically, the Office Action alleges that the claimed recitation of “a metal oxide having an oxygen content that is less than a stoichiometric amount,” as recited in Claim 1, is unclear as to what amount is the oxygen content of the metal oxide. *Id.* The Office Action further alleges that the claimed recitations of an oxygen-deficient metal oxide film and forming a metal oxide film on the oxygen-deficient metal oxide film are unclear because the metal oxide film can be a dielectric layer or a conductive layer, and it is allegedly unclear as to which type of structure Applicants refer. *Id.*

Regarding the Office Action’s allegation that it is unclear as to what amount of oxygen is in the oxygen-deficient metal oxide, Applicants assert that it is not necessary for the present specification to describe the stoichiometry of every metal oxide in order to distinctly claim the subject matter of Claims 1-6 and 11-15. One of ordinary skill in the art would know what a stoichiometric amount of oxygen is for a given metal oxide, and thus, one of ordinary skill in the art would also know what amount is “less than a stoichiometric amount.” Applicants have also provided a listing of exemplary metal oxides including Ta₂O₅, Y₂O₃, hafnium oxide (HfO₂), niobium oxide (Nb₂O₅), titanium oxide (TiO₂), barium oxide (BaO), strontium oxide (SrO), BST and lanthanum oxide (La₂O₃). *See Specification*, page 2, lines 15-19. Thus, Applicants submit that the amount of oxygen in the oxygen-deficient metal oxide film recited in Claims 1-6 and 11-15 would be ascertainable to those of ordinary skill in the art, and thus, these claims are not indefinite.

Regarding the Office Action’s allegation that Claims 1-6 and 11-15 are indefinite because they do not specify whether the metal oxide film is a dielectric or a conductive layer structure, Applicants respectfully disagree. However, in order to expedite prosecution, Applicants have amended Claim 1, 5, 6, 12 and 13 to recite methods of forming a dielectric film that include forming an oxygen-deficient metal oxide dielectric film and forming a metal oxide dielectric film thereon. Thus, Applicants believe the present rejection is now overcome.

For at least the reasons described above, Applicants submit that Claims 1-6 and 11-15 are not indefinite, and Applicants respectfully request that the present rejection be withdrawn.

Claims 1-6 and 11-15 Are Patentable Over Lim In View of Termath and Hayashi

The Office Action states that Claims 1-6 and 11-15 are rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Publication No. 2003/0040196 to Lim et al. ("Lim") in view of U.S. Patent No. 5,506,037 to Termath ("Termath") and U.S. Publication No. 2004/0065877 to Hayashi et al. ("Hayashi"). *Office Action*, page 3. The Office Action alleges that Lim teaches in Figure 5C and related text a method of forming a metal thin film, comprising: "forming an oxygen deficient metal oxide film 33 on a semiconductor substrate by atomic layer deposition (ALD, paragraph [0020]) using an organic metal compound as a first reactant (paragraph [0067]); and forming a metal oxide film 34 on the oxygen-deficient metal oxide film by ALD using the first reactant and a second reactant, wherein the second reactant comprises an oxidizing agent." *Id.* The Office Action then admits that Lim does not teach forming an oxygen-deficient metal oxide film that comprises a metal oxide having an oxygen content that is less than a stoichiometric amount. *Id.* However, the Office Action states that Termath and Hayashi teach forming an oxygen-deficient metal oxide film comprising a metal oxide film having an oxygen content less than the stoichiometric amount, and thus, it would have been obvious to one having ordinary skill in the art at the time the invention was made to use an oxygen-deficient metal oxide film comprising a metal oxide having an oxygen content that is less than a stoichiometric amount in Lim in order to improve device characteristics. *Office Action*, pages 3 and 4. The Office Action then states that the motivation to combine is based on the teachings of Termath and Hayashi, who allegedly point out the advantages of using an oxygen-deficient metal oxide film comprising a metal oxide having an oxygen content that is less than the stoichiometric amount. *Office Action*, page 4. The Office Action also provides additional reasoning as to why dependent Claims 2, 3, 5, 12-13 and 15 are also allegedly obvious over Lim in view of Termath and Hayashi. *Office Action*, pages 4 and 5.

Claim 1 recites:

A method of forming a dielectric film, comprising:
forming an oxygen-deficient metal oxide dielectric film on a semiconductor substrate by atomic layer deposition (ALD) using an organic metal compound as a first reactant, wherein the oxygen-deficient metal oxide dielectric film comprises a metal oxide having an oxygen content that is less than a stoichiometric amount; and
forming a metal oxide dielectric film on the oxygen-deficient metal oxide dielectric film by ALD using the first reactant and a second reactant,

wherein the second reactant comprises an oxidizing agent. *Emphasis added.*

Claim 1 is patentable over Lim in view of Termath and Hayashi for at least the reason that Lim does not teach or suggest forming an oxygen-deficient metal oxide dielectric film using an organic metal compound as a first reactant, and then forming a metal oxide dielectric film thereon using the first reactant and a second reactant. As Lim states, "FIG. 5c and FIG. 5d present a technology of alternatively stacking and oxidizing two different metal oxides to form a metal oxide film." Para. 0081, *emphasis added*. In addition, Lim explicitly states that these two different metal oxides include two different metals, M_1 and M_2 . *See, e.g.*, paragraph [0080]. Thus, the same organic metal compound cannot be used to deposit the M_1 and M_2 metal oxide layers in Lim. As Claim 1 recites using the same metal organic compound in forming both the oxygen-deficient metal oxide dielectric film and the metal oxide dielectric film, Lim does not teach this aspect of Claim 1. In fact, Applicants believe Lim teaches away from Claim 1 by specifically stating that M_1 and M_2 are different metals. Therefore, Applicants submit that Lim does not teach or suggest each and every recitation of Claim 1.

Furthermore, Applicants submit that neither Termath nor Hayashi cures the deficiencies of Lim, for at least the reason that neither reference describes using the same metal organic compound to form both an oxygen-deficient metal oxide dielectric film and a metal oxide film formed thereon. Applicants also submit that the combination of Lim with either Termath and/or Hayashi is improper for at least the reason that one of ordinary skill in the art would not be motivated to combine Lim with either Termath or Hayashi. The combination of Lim and Termath is inappropriate for at least the reason that Termath is directed to heat-reflecting and/or electrically heatable laminated glass panes. One of ordinary skill in the art of forming semiconductor devices would not be aware of Termath because it is directed to glass panes for automobile windows or windshields (*see, e.g.*, col. 1, lines 13-15). Furthermore, even if one of ordinary skill was aware of such a reference, (s)he would not expect that techniques used for glazing glass panes would be appropriate or desirable for use in fabricating semiconductor devices. The combination of Lim and Hayashi is inappropriate for at least the reason that Hayashi is directed to electroluminescent elements that include an oxygen-deficient metal oxide conductive film. *See* Abstract. One of ordinary skill in the art

would not substitute the conductive metal oxide film of Hayashi for a dielectric metal oxide film of Lim, and thus one of skill in the art would not combine Hayashi with Lim.

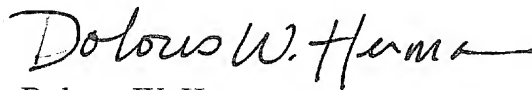
Therefore, Applicants submit that Claim 1 is patentable over Lim in view of Termath and Hayashi. In addition, Applicants submit that Claims 2-6 and 11-15 are also patentable over Lim in view of Termath and Hayashi, at least per the patentability of Claim 1 from which they depend. Thus, Applicants respectfully request that the present rejection be withdrawn

Conclusion

In view of the foregoing amendments and remarks, Applicants respectfully request that all outstanding rejections to the claims be withdrawn.

The Examiner is invited and encouraged to contact the undersigned directly if such contact will expedite the prosecution of the pending claims to issue. In any event, any questions that the Examiner may have should be directed to the undersigned, who may be reached at (919) 854-1400.

Respectfully submitted,



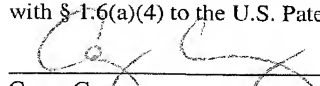
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Carey Gregory

Date of Signature: July 3, 2007